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ABSTRACT

The main aim of this study was to compare children diagnosed as dysphonetic and dyseidetic on a number of mental processing variables to determine if opposite patterns of relative strength and weakness between the groups could be documented. Another aim was to externally validate the diagnostic criteria, which were based on standardized clinical tests of reading and related abilities. Two matched groups of 8- to 11-year-olds were selected by means of historically conventional criteria for diagnosis of dyslexia. The dysphonetic group (N=31) had poor nonword decoding and limited phonetic skills in spelling unknown words. The group also had more regular word miscues in relation to irregular word miscues at frustration level than expected. The dyseidetic group (N=18) showed the opposite patterns. Measures of rhyming, word segmentation, phonological integration, orthographic and phonological processing, verbal and nonverbal memory storage and retrieval, and parent-rated and clinically-tested attention were given to each group. Reliable differences between the groups in higher-level phonological skills, and trends toward developmental differences in lower-level phonological skills and an orthographic and phonological double dissociation, supported the validity of the subgroups. Memory and attention measures did not differ between the groups. (RH)

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PHONOLOGICAL PROCESSING, VERBAL AND NONVERBAL MEMORY, AND ATTENTION IN DYSPHONETIC AND DYSEIDETIC DYSLEXIA*

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ABSTRACT

The validity of the dysphonetic or auditory-linguistic versus dyseidetic or visuo-spatial dyslexia subgroups, defined on the basis of patterns of reading behaviors, is tested in relation to a number of underlying or associated mental processing skills. Using historically conventional criteria for diagnosis of dyslexia in general, including average intelligence and marked delay on a number of reading measures, two matched groups of 8- to 11-year olds were selected. The dysphonetic group (N=31) had poor nonword decoding, limited phonetic skills in spelling unknown words, and more regular word miscues in relation to irregular word miscues at frustration level than expected. The dyseidetic group (N=18) showed the opposite patterns. Measures of rhyming, word segmentation, phonological integration, orthographic and phonological processing, verbal and nonverbal memory storage and retrieval, and parent-rated and clinically tested attention were given to each group. Reliable differences between the groups in higher-level phonological skills, and trends toward developmental differences in lower-level phonological skills and toward an orthographic/phonological double dissociation, supported the validity of the subgroups. Memory and attention measures did not differ between the groups. Accompanying research on differential responses to two reading instruction approaches in a large sample (N=96) and on topographic brain mapping will attempt to further validate the defined subgroups.

INTRODUCTION

Many researchers over the past 15 years have identified two subgroups of dyslexia as important and prevalent, and have hypothesized that they should respond best to different instructional approaches. These have been termed dysphonetic or auditory-linguistic dyslexia, and dyseidetic or visuo-spatial dyslexia (see Hynd & Cohen, 1983 for review). More recently, this dichotomy has been questioned, and alternative models have been proposed. These include the idea that all children with dyslexia fall on a continuum of more or less severe phonological disability (Stanovich, 1988); the postulate that phonological reading problems are primarily inherited, but orthographic problems are acquired through environmental factors (Olson et al., 1988); and the theory that dysphonetic dyslexia represents a skill deficit, but dyseidetic dyslexia represents an overuse of phonics strategies rather than a specific, separate mental processing deficit (Flynn, 1989). The main aim of the present study was to compare carefully diagnosed dysphonetic versus dyseidetic children on a number of mental processing variables to determine if

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opposite patterns of relative strengths and weaknesses between the groups could be documented. A closely related aim was to externally validate our particular diagnostic criteria, which were based on commonly used, standardized clinical tests of reading and related abilities.

METHOD

SUBJECTS were 33 children with dysphonetic dyslexia and 18 children with dyseidetic dyslexia. Diagnosis as dyslexic was based on the following criteria:

1. WISC-R Verbal IQ or Performance IQ $\geq$ 90, with the other IQ score $\geq$ 80.

2. Reading below average on at least three out of four measures: Standard scores <90 on Woodcock Reading Mastery Test-Revised (WRMT-R) Word Identification and Passage Comprehension subtests, and Reading Expectancy Quotients < 90 for word recognition and reading comprehension on the Qualitative Reading Inventory (Caldwell & Leslie, in press) instructional levels with familiar narrative text.

3. Normal or corrected vision and hearing, based on school screening or parent report of professional examination.

4. Adequate educational opportunity, by review of educational history.

5. If emotional, social, behavioral or family disturbance present, not primary cause of reading problem, by parent report and by review of history.

Subgroups were assigned by two of the following three criteria, which excluded mixed or nonspecific disabled readers:

Dysphonetic (N=31)	Dyseidetic (N=18)
1. Dysphonetic spelling pattern on modified Boder Test with a restricted range of eligible unknown spelling words.	1. Dyseidetic spelling pattern on modified Boder Test with a restricted range of eligible unknown spelling words.
2. WRMT-R Word Attack standard score < 85.	2. WRMT-R Word Attack standard score > 85.
3. Discrepancy between regular and irregular words correct at frustrational level on Boder > 25%.	3. Discrepancy between regular and regular words correct at frustrational level on Boder < 25%.

Clinical diagnosis of dysphonetic and dyseidetic subgroups has typically relied upon the psychometrically weak Boder Test. Modifications employed here in selecting spelling words on the Boder and the addition of the psychometrically stronger Woodcock Word Attack paradigm probably contributed to the present evidence for the validity of the subgroups.

The two groups were not significantly different on age (M = 9.5 years, range 7.4 to 11.3), sex (80% male), grade placement (M = 3.2, range 2 to 6), overall reading instructional level (M = 2nd grade, range preprimer to 3rd grade), socioeconomic status (M Hollingshead 4-factor = 44, range 23 to 66), or any IQ scores (Full Scale IQ M = 103.4, range 85 to 124) (t's (46 to 50) range -1.7 to 1.0, $p > 0.9$).

Analyses. Dependent measures were analyzed in the three sets outlined below, using untransformed raw scores or scaled scores where available. Each set underwent a MANOVA for two independent samples with instructional level as a covariate, followed by preplanned univariate F tests.

PHONOLOGICAL AND ORTHOGRAPHIC PROCESSING

Hypotheses: Dysphonetic dyslexic children will perform more poorly than dyseidetic dyslexic children on several measures of phonological processing, and the former will show a greater discrepancy between orthographic and phonological processing than the latter.

Tasks:

RHYME SUPPLY (Stanovich et al., 1984): Child states real-word rhyme for orally presented, single-syllable stimulus words (e.g. nose, pup). Score is number correct out of 10 trials.

SOUND SEGMENTATION from Test of Awareness of Language Segments (Sawyer, 1987): Child selects number of blocks corresponding to the number of phonemes in orally presented, single-syllable words (e.g. leaf, plan). Score is number correct out of 18 trials, discontinuing after 6 incorrect responses.

ELLISION from Auditory Analysis Test (Rosner, 1971): Child repeats orally presented words with specified sounds removed (e.g. "glow" without the "l" sound becomes "go"). Score is number correct out of 40 trials, discontinuing after 4 consecutive incorrect.

LEXICAL DECISION (Olson et al., 1985): In orthographic condition, child selects which of two identical-sound letter groups is the correct spelling or "real" word (e.g. room & rume). In phonological condition, child selects which of two non-word letter groups sounds like a "real" word when sounded out (e.g. dake & kake). Each condition has 40 two-choice items, and response is pointing, requiring no expressive speech. Score is total correct on orthographic minus total correct on phonological conditions.

Results: A significant MANOVA was followed by significant differences on two of four variables (see Table 1). Dyseidetics were substantially better than dysphonetics on ellision, and dyseidetics had a smaller discrepancy between orthographic and phonological processing than dysphonetics.

Table 1 Mean Phonological and Orthographic Processing Scores

	Dysphonetic Mean	Dyseidetic Mean	F(4,43)
Multivariate Hotellings T^2			2.79*
RHYME	8.10	8.00	0.05
SEGMENTATION	13.84	15.17	2.57
ELLISION	12.55	18.11	7.46**
LEXICAL DECSN	6.29	2.94	4.32*

* $p < .05$ ** $p < .01$

Phonological Tasks for Subjects at Preprimer, Primer and First Grade Instructional Levels: The absence of differences between the two subtypes on the two phonological tasks that involve segmentation only (SEGMENTATION) or segmentation and holding (RHYME) may indicate that many dysphonetics possess these more basic phonological processing skills but still fall down on integration, particularly if they are beyond the lowest reading levels. In fact, the test from which the SEGMENTATION task was taken is normed only through age 7.5 years, and the RHYME type of task employed here is usually used in research on younger prereading or early reading children.

Restricting the sample to the 16 dysphonetics and 7 dyseidetics reading at or below the first grade level yielded a MANOVA that approached significance on these more basic tasks, and univariate analyses showed the dysphonetics lower than the dyseidetics on SEGMENTATION (see Table 2)

Table 2 Phonological Tasks for Subjects at Lower Reading Levels

	Dysphonetic Mean	Dyseidetic Mean	F(2,19)
Multivariate Hotellings T^2			2.76#
RHYME	7.81	7.86	0.01
SEGMENTATION	13.81	16.28	5.16*

* $P < .05$ # $P = .089$

Lexical Decision Tasks Analyzed Individually: In order to validate the two subtypes diagnosed here, it would be ideal to demonstrate a double dissociation between them on some tasks. For instance, it could be predicted that dysphonetics should be strong in orthographic processing and weak in phonological processing, and vice versa for dyseidetics. Within the context of the orthographic portion of the LEXICAL DECISION tasks being easier for the sample as a whole than the phonological portion, a trend toward such a double dissociation is demonstrated when the tasks are analyzed individually (see Table 3). If substantiated in future analyses, this trend would demarcate the dyseidetic subgroup as a distinct dyslexic variant rather than a less severe

form on a continuum, and it would fill a gap in the illusive search for the nature of the "visual-spatial" deficit in this subgroup.

Table 3 Mean Performance on Lexical Decision Tasks Analyzed Individually

	Dysphonetic Mean	Dyseidetic Mean	F(2,47)	p
Multivariate Hotellings T^2			2.25	.117
ORTHOGRAPHIC	32.15	30.11	2.28	.138
PHONOLOGICAL	25.78	27.17	0.77	.385

Conclusions: The clinical methods for diagnosis that were employed here yield subgroups of mid- to late-elementary school children that embody major facets of phonological processing which predominate current research on the underlying mental processing in dyslexia. Phonological decoding of words requires a hierarchy of skills from simple sound segmentation, maintaining phonological information in working memory, and integrating phonological clusters. Our dysphonetic group is poorer than the dyseidetic group in relatively higher-order phonological processing skills combining segmentation and integration, although the lowest level readers in these groups may also differ in simple segmentation skills. A trend toward a double dissociation between dysphonetic and dyseidetic dyslexic children on orthographic versus phonological processing was suggested, but this finding was not statistically reliable with the present sample. This result will be reinvestigated when all subjects in this research project have been tested. Further analyses will also investigate the relative advantages and validity of a subgroup versus continuous distribution model of the differences among dyslexic children.

MEMORY

Hypotheses: Dysphonetic dyslexic children will show poorer long-term verbal memory st and retrieval than dyseidetic dyslexic children, and vice-versa for long-term nonverbal storage and retrieval.

Tasks:

WISCONSIN SELECTIVE REMINDING TEST: Locally developed, version of Buschke's (1973) selective reminding paradigm, using 12 unrelated concrete (e.g. arm) and abstract (e.g. soul) words and 10 trials. Scores are total long-term storage, total consistent long-term retrieval and total 30-minute delayed recall.

NONVERBAL SELECTIVE REMINDING TEST (Fletcher, 1985): Child points to the one correct dot previously indicated by examiner within each of eight 5-dot arrays, with 8 learning trials in the selective reminding paradigm. Scores are total long-term storage, total consistent long-term retrieval and total 30-minute delayed recall.

Results: No differences between subgroups were substantiated, on either multivariate or univariate tests (see Table 4).

Table 4 Mean Selective Reminding Test Scores

	Dysphonetic Mean	Dyseidetic Mean	F(6,37)
Multivariate Hotellings T^2			0.78
WISCONSIN SELECTIVE REMINDING TEST			
STORAGE	63.60	66.13	0.10
RETRIEVAL	37.90	39.67	0.04
DELAY	7.40	7.07	0.32
NONVERBAL SELECTIVE REMINDING TEST			
STORAGE	36.57	37.46	0.04
RETRIEVAL	23.03	28.73	1.30
DELAY	4.97	5.07	0.02

Conclusions: Anticipated differences in the verbal versus nonverbal long-term memory of dysphonetic and dyseidetic children were not demonstrated. Previously documented deficits in specific aspects of immediate or working memory, or in what is sometimes termed the phonological buffer, in some reading disabled children may be more salient in distinguishing dyslexic from nondyslexic children. However, the present study did not find differences between these two subtypes of dyslexics on a measure of this factor that is often deficient in some reading disabled samples, i.e. digit span.

ATTENTION AND WORKING MEMORY

Hypotheses: The two subgroups will not differ on general clinical indicators of atten problems. However, dysphonetic dyslexic children will show lower immediate sequential recall of phonologically encoded items (digit span) than dyseidetic dyslexic children, and vice versa for immediate visual-nonverbal sequential recall.

Tasks:

CHILD BEHAVIOR CHECKLIST HYPERACTIVITY SCALE (Achenbach & Edelbrock, 1983): Subscale from parent-completed multidimensional behavior rating scale. Score is T-score (mean = 50, standard deviation = 10), with higher scores indicating more pathology.

WISC-R FREEDOM FROM DISTRACTIBILITY FACTOR: Score is mean of scaled scores from Arithmetic, Digit Span and Coding subtests.

WISC-R DIGIT SPAN: Immediate forward and backward recall of increasingly long series of digits. Score is scaled score.

KNOX CUBE TEST: Nonverbal analog of Digit Span, using increasing long series of patterns tapped out by examiner on four equally spaced blocks. Score is scaled score.

Results and Conclusions: No significant differences between the groups were seen on general clinical indicators of attention (see Table 5). Although both general indicators were within the average ranges in reference to standardized norms, tendencies toward attention problems were indicated. No difference on phonologically encoded working memory was found, but dyseidetics were reliably better than dysphonetics on the nonverbal immediate memory measure. Although the latter finding is only questionably interpretable in light of the nonsignificant MANOVA, it could indicate a relative problem with some aspect of sequential mental processing in the dysphonetic group.

Table 5 Mean Scores on Measures of Attention and Working Memory

	Dysphonetic Mean	Dyseidetic Mean	F(4,21)
Multivariate Hotellings T^2			2.34
CHECKLIST	60.79	63.62	1.04
DISTRACTIBILITY	8.96	8.91	0.00
DIGIT SPAN	9.37	9.87	0.16
KNOX CUBE	9.47	11.37	5.02*

* $p < .05$

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